Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

A99.9 F764U

INT-FILE COPY

FOR XEROX USE ONLY
PLEASE RETURN TO PROPER PLACE

CONE SEROTINY OF LODGEPOLE PINE NEAR ISLAND PARK, IDAHO

JAMES E. LOTAN

RESEARCH PAPER INT-52, 1968
Intermountain Forest & Range
Experiment Station
Ogden, Utah 84401

U.S. Forest Service
Research Paper INT-52
1968

CONE SEROTINY OF LODGEPOLE PINE NEAR ISLAND PARK, IDAHO

James E. Lotan

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Forest Service
U.S. Department of Agriculture
Ogden, Utah 84401
Joseph F. Pechanec, Director

INTRODUCTION

The serotinous cone fruiting habit is an important factor in the silviculture of lodgepole pine (*Pinus contorta* Dougl.) in the northern Rocky Mountain and Intermountain regions. The usual practice of block clearcutting depends upon an adequate supply of stored seed in serotinous cones (Bates, Hilton, and Krueger 1929; Boe 1956; Tackle 1961, rev.; 1964). Lodgepole pine does not normally disperse sufficient seed for adequately reproducing a stand beyond about 3 chains from the timber edge (Boe 1956; Tackle 1964). The several years' seed supply stored in serotinous cones is the source of seed for regenerating the clearcut block beyond this distance. Natural regeneration is usually superabundant. However, areas exist where regeneration has been difficult to obtain, particularly in southeastern Idaho.

Most Rocky Mountain stands have been considered as bearing an abundance of serotinous cones, but recent evidence has shown that significant local variation exists (Lotan 1967). Individual trees in the same stand vary in fruiting habits, most trees distinctively bearing either open or closed cones (Clements 1910; Mason 1915); and to date no one has clearly demonstrated causal factors related to the habit. (In this paper, the term "closed cone" is equivalent to "serotinous cone.")

To learn more about the degree of cone serotiny in lodgepole pine and the number of closed cones per acre, we sampled stands on two physiographic areas located just west of the Continental Divide near Island Park, Idaho, on the Targhee National Forest. The survey was started in 1961 and completed in 1964 using a previously developed sampling technique (Lotan 1963). The areas had been designated as difficult to reforest, and other regeneration studies (including seedling survival studies) were centered there (Lotan 1964a).

METHODS

Sampling was stratified by two elevational levels (fig. 1) divided by a plateau front at about 7,000 feet elevation: (1) Island Park Flat with an average 6,500-foot elevation and (2) Moose Creek Plateau with an average 7,700-foot elevation. A total area of about 60,000 acres (nearly equally divided between the two elevational strata) was sampled within the boundary of the Moose Creek Plateau timber sale of 1960. Some stand characteristics from the two strata are compared in table 1.

SAMPLING TECHNIQUE

Fifty-nine systematically located 1/50-acre plots were established in alternate square miles, and a total of 229 trees sampled. Within each plot all trees 5.6 inches d.b.h. and larger were felled, and closed cones were counted on 25 outer-1-foot branch segments in the upper portion of the crown of each tree. The tree was sampled from the top downward until the 25 samples were taken. All closed cones were counted on 59 trees to obtain a regression formula for estimating total closed cones on the remaining trees. Part of these total-count trees were used in a previously reported formula (Lotan 1967). From these data the following regression formula was computed:

$$\hat{Y} = 253X - 215$$

where $\hat{Y}$ = total serotinous cones per tree, and X = mean serotinous cones per sampled branch segment. The correlation coefficient is 0.814, and the standard error of estimate is 84 cones. The half-confidence interval for the population mean is 114 cones per tree at the 5-percent level of probability.

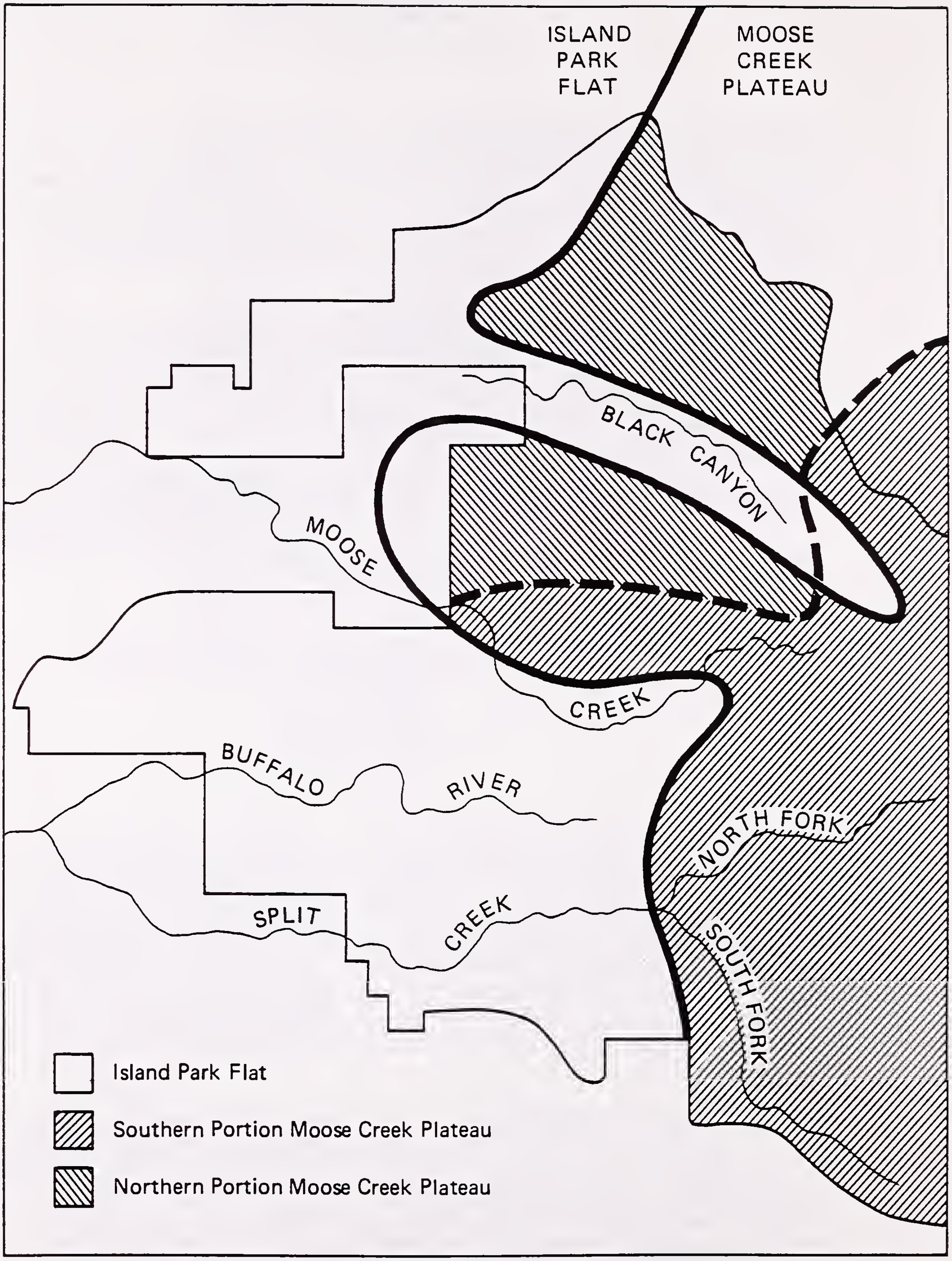

Figure 1.–Location of study area, Island Park Ranger District, Targhee National Forest, Idaho, 1964.

Current and open cones were counted on the 25 samples from each tree to determine the percentage of closed cones per tree and the percentage of trees bearing closed cones in the stands. This gave a tree-by-tree comparison of the closed-cone habit independent of variation in cone production of individual trees.

Data were collected on plot and tree factors that we thought might be related to the percentage of serotinous cones on a tree: elevation of the plot; and a numerical rating of dwarfmistletoe, d.b.h., total height, percent live crown, crown class, vigor class, and age for each tree.

Table 1. – *Characteristics of stands in serotinous cone survey, Targhee National Forest, 1964*

Study area	Average age	Average d.b.h.	Average total height
	Years	*Inches*	*Feet*
Island Park Flat	117 ± 8[1]	10.0 ± ½	66 ± 2
Moose Creek Plateau	191 ± 12	12.5 ± ½	61 ± 2

[1] *Standard error of the mean at the 95-percent level of probability.*

RESULTS AND DISCUSSION

The results on the Targhee National Forest were similar to those obtained on the Gallatin National Forest (Lotan 1967) in that adjacent areas have produced varying degrees of cone serotiny. The trees on Island Park Flat produced more than three times as many serotinous cones per acre as those on the upper level (table 2). These stands had more trees per acre, a greater average number of closed cones per tree (table 2), and a greater percentage of trees bearing predominantly serotinous cones (table 3) than stands on the Moose Creek Plateau.

Also, as previously reported (Lotan 1967), the closed-cone fruiting habit of individual trees on these areas was usually quite pronounced. Only about 20 percent of the trees were classified "intermediate" (table 3) in fruiting habit on both areas–slightly more than the previously reported 10-14 percent. Trees were classified as *serotinous* if they bore 90 percent or more closed cones and *open* if they bore 10 percent or less closed cones. Of the trees growing on Island Park Flat, 48 percent were serotinous; of those on Moose Creek Plateau, 23 percent were serotinous.

Although data collected on the Moose Creek Plateau were not formally substratified, a sharp break was observed in the number of cones per acre north and south of a line indicated in figure 1. North of this arbitrary line (no logical basis was found to stratify these data other than the difference in results) plots averaged 105,000 cones per acre, and more than half of the plots had over 100,000 cones per acre. South of this line, average number of cones per acre was only 15,000, and over half of the plots had no cones. The percentage of "serotinous" trees was not too greatly different on these two substrata–19 percent on the southern portion and 26 percent on the northern portion.

It is difficult to explain the differences in fruiting habit obtained in this study. A multiple regression of recorded plot and tree factors explained less than 10 percent of the variation in percentage of serotinous cones per tree. The two most obvious statistical contributors are elevation and age of the stands. However, superimposed upon this is a difference in stand history. Most of the Island Park Flat has been "tie-

Table 2.–*Estimated average serotinous cones per acre in stands near Island Park, Idaho, 1964*

Study area	Average trees per plot	Average serotinous cones per tree	Average serotinous cones per acre	Average sound seed per cone[1]	Average sound seed per acre
			Thousand		*Million*
Island Park Flat	4.4	772	173	10.7 ± 3.1	1.8
Moose Creek Plateau	3.5	295	53	15.7 ± 3.2	0.8
North portion	4.2	500	105	16.2 ± 5.4	1.7
South portion	3.1	94	15	15.1 ± 3.7	0.2

[1] *Standard error of the mean at the 95-percent level of probability.*

Table 3.–*Variation of serotinous cone habit in stands near Island Park, Idaho, 1964*

Study area	Trees bearing predominantly serotinous cones[1]	Trees intermediate in cone habit[2]	Trees bearing predominantly open cones[3]
		- - - - - - - - -Percent- - - - - - - - - -	
Island Park Flat	48	19	33
Moose Creek Plateau	23	20	57

[1] *Trees bearing 90 percent or more serotinous cones.*
[2] *Trees with more than 10 but less than 90 percent serotinous cones.*
[3] *Trees bearing 10 percent or less serotinous cones..*

hacked," that is, selected larger trees (11 to 16 inches d.b.h.) were removed for railroad ties about 1935. Most of the stands on the Moose Creek Plateau are extremely overmature, with individual trees over 400 years old. A linear regression with plot elevation and tree age as independent variables explained only 5 percent of the variation. On the Gallatin National Forest (Lotan 1967) a strong genetic component was suggested because the highest percentage of serotinous-coned trees occurred in an even-aged stand originating from fire–these trees no doubt originated from closed cones in the previous stand. In that study the high percentage of open-coned trees was found in stands that, for the most part, originated from open-coned trees.

Crossley studied fruiting habit of lodgepole pine in Canada (Crossley 1956) and suggested a possible age relationship to closed-cone habit, with very young stands (17 years old) bearing open cones and 55- to 250-year-old stands bearing closed cones. In the present study the age spread was too limited to detect this relationship.

Silviculturally, the data show that there should be sufficient seed stored in closed cones to regenerate the stands by block clearcutting if slash is handled properly (Boe 1956; Lotan 1964b; Tackle 1964). Slash must be exposed to radiant energy near the surface of the ground to melt the resin bond holding the cone scales and must be dozer-piled before germination occurs. Timing is of the essence.

The amounts of seed stored in closed cones as reported in this study give approximate estimates of the biotic potential for seedling establishment beginning with sound seed. Other studies such as that reported by Lotan (1964a) provide guides to the probabilities for germination and survival of available seed. However, the results as reported by Lotan were values for an above-average year with respect to moisture conditions.

The estimated sound seed values on the Moose Creek Plateau may be marginal. If we assumed a goal of 1,000 established 1-year-old seedlings per acre and a probability of 0.02 (seed-to-seedling ratio of 50:1) for seedling survival after 1 year, we would then need 50,000 sound seed per acre to produce our goal of 1,000. Our unknown probability in this situation is the proportion of the 800,000 sound seed per acre that will be released from cones and fall upon the soil. This gives us 16 times the number of seed required upon the seedbed to allow for this unknown probability. This amount will probably be adequate for good years but may not be so for abnormally dry years. We need more information on probabilities of success.

This study accomplishes little toward elucidating factors of cone serotiny except to point out problems involved in studying the matter and some implications of local variation. We are left with many questions. What is the relation between the serotinous cone habit and fire? Is regeneration by fire highly selective for the closed-cone habit as I hinted in discussion of the Gallatin National Forest data (Lotan 1967)? What is the relation of serotinous cone habit to other destructive agents such as the mountain pine beetle and dwarfmistletoe? What are the effects of management in selecting for or against the closed-cone habit? Because of the importance of the cone habit in the silviculture of lodgepole pine (whether for timber, watershed, esthetics, or whatever), further research is needed into this interesting phenomenon.

LITERATURE CITED

Bates, Carlos G., Huber C. Hilton, and Theodore Krueger.
1929. Experiments in the silvicultural control of natural reproduction of lodgepole pine in the central Rocky Mountains. J. Agr. Res. 38(4): 229-243, illus.

Boe, Kenneth N.
1956. Regeneration and slash disposal in lodgepole pine clear cuttings. Northwest Sci. 30(1): 1-11, illus.

Clements, F. E.
1910. The life history of lodgepole burn forests. U.S. Dep. Agr., Forest Serv. Bull. 79, 56 pp., illus.

Crossley, D. I.
1956. Fruiting habits of lodgepole pine. Can. Dep. North. Aff. and Nat. Resources, Forest. Br., Forest Res. Div. Tech. Note 35, 32 pp., illus.

Lotan, James E.
1963. Sampling serotinous cones in lodgepole pine. Mont. Acad. Sci. Proc. 23: 20-24, illus.

Lotan, James E.
1964a. Initial germination and survival of lodgepole pine on prepared seedbeds. U.S. Forest Serv. Res. Note INT-29, 8 pp., illus.

Lotan, James E.
1964b. Regeneration of lodgepole pine: a study of slash disposal and cone opening. U.S. Forest Serv. Res. Note INT-16, 4 pp., illus.

Lotan, James E.
1967. Cone serotiny of lodgepole pine near West Yellowstone, Montana. Forest Sci. 13(1): 55-59, illus.

Mason, D. T.
1915. The life history of lodgepole pine in the Rocky Mountains. U.S. Dep. Agr. Bull. 154, 35 pp., illus.

Tackle, David.
1961, rev. Silvics of lodgepole pine. Intermountain Forest and Range Exp. Sta. Misc. Pub. 19, 24 pp., illus.

Tackle, David.
1964. Regenerating lodgepole pine in central Montana following clear cutting. U.S. Forest Serv. Res. Note INT-17, 7 pp., illus.

Lotan, James E.
1968. Cone serotiny of lodgepole pine near Island Park, Idaho. U.S. Dep. Agr.,
Forest Serv., Intermountain Forest and Range Exp. Sta., Ogden,
Utah 84401. 6 pp., illus. (U.S. Forest Serv. Res. Pap. INT-52)

Stands of *Pinus contorta* Dougl. on adjacent physiographic areas in southeastern Idaho vary in the serotinous cone fruiting habit. On the Island Park Flat (average elevation 6,500 feet) 48 percent of the trees were classified as predominantly serotinous cone trees (bearing 90 percent or more serotinous cones). On the nearby Moose Creek Plateau (average elevation 7,700 feet) only 23 percent of the trees were classified as serotinous cone trees. The Island Park Flat produced 173,000 serotinous cones per acre, whereas the Moose Creek Plateau produced only 53,000 such cones per acre. Cone habit showed no relation to common plot and tree parameters measured.

Lotan, James E.
1968. Cone serotiny of lodgepole pine near Island Park, Idaho. U.S. Dep. Agr.,
Forest Serv., Intermountain Forest and Range Exp. Sta., Ogden,
Utah 84401. 6 pp., illus. (U.S. Forest Serv. Res. Pap. INT-52)

Stands of *Pinus contorta* Dougl. on adjacent physiographic areas in southeastern Idaho vary in the serotinous cone fruiting habit. On the Island Park Flat (average elevation 6,500 feet) 48 percent of the trees were classified as predominantly serotinous cone trees (bearing 90 percent or more serotinous cones). On the nearby Moose Creek Plateau (average elevation 7,700 feet) only 23 percent of the trees were classified as serotinous cone trees. The Island Park Flat produced 173,000 serotinous cones per acre, whereas the Moose Creek Plateau produced only 53,000 such cones per acre. Cone habit showed no relation to common plot and tree parameters measured.

Lotan, James E.
1968. Cone serotiny of lodgepole pine near Island Park, Idaho. U.S. Dep. Agr.,
Forest Serv., Intermountain Forest and Range Exp. Sta., Ogden,
Utah 84401. 6 pp., illus. (U.S. Forest Serv. Res. Pap. INT-52)

Stands of *Pinus contorta* Dougl. on adjacent physiographic areas in southeastern Idaho vary in the serotinous cone fruiting habit. On the Island Park Flat (average elevation 6,500 feet) 48 percent of the trees were classified as predominantly serotinous cone trees (bearing 90 percent or more serotinous cones). On the nearby Moose Creek Plateau (average elevation 7,700 feet) only 23 percent of the trees were classified as serotinous cone trees. The Island Park Flat produced 173,000 serotinous cones per acre, whereas the Moose Creek Plateau produced only 53,000 such cones per acre. Cone habit showed no relation to common plot and tree parameters measured.

Lotan, James E.
1968. Cone serotiny of lodgepole pine near Island Park, Idaho. U.S. Dep. Agr.,
Forest Serv., Intermountain Forest and Range Exp. Sta., Ogden,
Utah 84401. 6 pp., illus. (U.S. Forest Serv. Res. Pap. INT-52)

Stands of *Pinus contorta* Dougl. on adjacent physiographic areas in southeastern Idaho vary in the serotinous cone fruiting habit. On the Island Park Flat (average elevation 6,500 feet) 48 percent of the trees were classified as predominantly serotinous cone trees (bearing 90 percent or more serotinous cones). On the nearby Moose Creek Plateau (average elevation 7,700 feet) only 23 percent of the trees were classified as serotinous cone trees. The Island Park Flat produced 173,000 serotinous cones per acre, whereas the Moose Creek Plateau produced only 53,000 such cones per acre. Cone habit showed no relation to common plot and tree parameters measured.

NATIONAL AGRICULTURAL LIBRARY
1022966884

THE AUTHOR

JAMES E. LOTAN has been Project Leader of the Intermountain Station Silviculture of Lodgepole Pine Research Project, located in Bozeman, Montana, since 1965. He has been a member of the Project since 1961 and has published a number of articles on lodgepole pine management.